SPECIAL PROBLEMS OF DETERIORATI

IN ARMY WATERFRONT STRUCTURES

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INTRODUCTION

During recent years there has been an increased interest in the deterioration of wood and wood products and particularly in the damage caused to buildings. This attitude is due, to a considerable extent, to the increasing values of properties and the high cost of their maintenance. Costs for some grades of lumber and structural timber has increased approximately 200% since 1942.

There are other reasons, however. The wide use of second growth timber as a structural wood has resulted in losses greater than heretofore known due to insect damage, decay, and other forms of deterioration. Such woods, particularly second-growth southern pines, contain little heartwood and a considerable volume of sapwood which lacks resistance to deterioration.

Changes in style of building construction have also created conditions favorable to insects. The practice of erecting a structure upon a concrete slab, for example, favors termite activity. The use of heating systems in cold climates has had a marked influence--large central heating and humidifying units serve to create conditions, even in the sub-structure of buildings, that enable insects to continue their destructive activities throughout the entire year rather than on a seasonal schedule as they would normally do.

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In recent years revolutionary advances in the field of pest control, particularly in the development of synthetic organic insecticides and the equipment for applying them, have opened possibilities for insect control never before realized. The value of these new chemicals should be tested for the protection of wood by surface treatments, soakage, and the use of the pressure-vacuum process.

Estimates of current losses due to such organisms as subterranean and non-subterranean termites, wood borers, powder-post beetles, marine

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borers, and decay, are astounding. In the Canal Zone alone, the Corps of Engineers was, until recently, spending almost $500,000 annually for repairs to buildings damaged by subterranean termites. Establishment of an effective termite control program has reduced these losses greatly. Losses caused by non-subterranean termites, though not so great, are very high also, particularly in the semi-tropics and tropics. In certain areas, such as the Florida Keys and the West Coast, they are far more severe than subterranean forms. There are a large number of other wood boring insects which in the aggregate destroy finished products valued at several million dollars annually. Accurate estimates of these losses are unavailable due mainly to the fact that, because of the insidious nature of the insects' activities, they have attracted less attention and, as a result, have been less intensively investigated.

In the discussion that follows the fact should be kept in mind that the various groups of insects mentioned, as well as the wood-rotting fungi, reach their optimum development under conditions existing in shore environments. This is due mainly to the high relative humidity and heavy rainfall occurring in such areas and, in warm climates, to the prevalence of high temperatures.

A brief discussion of the various groups of organisms will serve to acquaint the audience with the nature of their habits, distribution, and the destruction they cause.

DISCUSSION OF PROBLEMS OF DETERIORATION

Termites

Termites are the most destructive of all wood boring insects attacking wood structures. Distributed the world over, they have attracted a great deal of attention and study by scientist and layman alike. Thus, there is a wealth of literature surrounding these interesting forms, some of it truly scientific, but much of it erroneous and bordering on the fantastic. For many years termites were known as white ants, an erroneous nomenclature which persists to this day. Actually, they are not even remotely related to ants nor are they necessarily white. Rather, they are a primitive group of insects, related to the cockroach, and comprise a distinct order of their own. However, like ants, they are social insects living in large colonies organized in a caste system, the castes usually consisting of winged adults and wingless soldiers and workers.

There are innumerable species of termites with wide variations in character and habit; however, only two general types need be considered from an economic viewpoint--namely the subterranean and drywood termites.

Subterranean termites are so called because of their habit of maintaining the center of their activities, the colony, below the soil. The castes normally consist of dark-colored winged adults and soft-bodied, cream or white-colored soldiers and workers. The normal function of termites is that of consuming and decomposing cellulose materials, such as dying and dead plant life, back into organic matter of the soil. However, if they are deprived of this and buildings occupy the site, the termites are capable of infesting the structures either by direct entry into readily accessible structural wood, or, if the wood is some distance away, by means of earthen shelter tubes built over obstructions. Thus, by constructing these tubes, which incidentally are humidified and ventilated, termites can progress from their colony deep in the earth over brick, concrete, or masonry, or through tiny cracks in these units, and even over treated wood, until they reach the untreated wood or other cellulose products they desire. While they normally confine their activities to wood in the foundation structure, it is not unusual for these insects to extend their activities into the second or third story in order to reach suitable food; this is particularly true in shore areas where high humidities prevail.

The key to successful control of subterranean termites therefore lies in proper foundation structures which involves eliminating from the building site all scrap wood which will serve as food for termites and permit an increase in termite populations. It involves construction of impenetrable foundations and good drainage and ventilation to discourage termite activity, and requires that structural wood be well above the soil or, if it must be in contact, that it be pressure-treated with an approved preservative. However, it must be remembered that, while these recommendations are basic, they will not perform with equal effect under any and all conditions and in all localities. For example, on the upper Atlantic coast a structure on a chain wall or pier foundation properly ventilated and drained is in most cases amply protected. However, in the semi-tropics or tropics, where termites are favored by high humidities and their populations are high, these precautions have little value in discouraging them. In recent years there has been an increasing trend toward construction of all-masonry or concrete structures with very little wood used. This might appear to be an excellent method of termite control, but at present the point is debatable. Unless the foundation is of monolithic construction and not subject to cracking, and unless all holes, pipe chases, etc., are properly sealed, hidden infestations can result which are more serious than those occurring in conventional structures. Studding, framing, and other wood can be destroyed. Such damage can be remedied only by tearing out units to determine points of termite entry and drilling the concrete floor to poison the soil. Even where no such wood as the above exists, termites will still damage furniture, rugs, clothing, and other wood and cellulose products. It might be well to point out here that they may bore through products other than those containing cellulose. Lead, aluminum, certain plastics, natural and neoprene rubber, and asphalt are a few of the materials subterranean termites have been known to penetrate in their search for food.

Where the application of preventive structural methods fails to control these insects or where it is impractical, poisoning the soil at points where they are entering a building may be a highly effective control measure. This procedure is widely used; however, there is considerable misuse and misunderstanding about effective poisons and method of application. The poisons which have been used in past years are almost innumerable, and many fallacies exist regarding some of them. It has frequently been claimed, for example, that salt will control termites, and, on this premise, that waterfront buildings will not be readily infested. An outstanding example of the fallacy of this notion appeared during a termite inspection in 1940 at Ft. Hancock on Sandy Hook, New Jersey. Practically every building, including those built at the waters edge, had infestations of varying severity. Basically, there are very few chemicals that have the qualifications of a good soil poison which primarily include permanency and minimum toxicity to plants and animals.

The opportunities for improved termite control opened up by the development of new insecticides and equipment now require considerable research to evaluate and adapt them to practical use as soil poisons, wood impregnants, and surface treatments.

Non-subterranean termites are more important as wood destroyers in certain localities than are the subterranean species. Furthermore, they present a greater problem because of the difficulty of controlling them.

These termites are widely distributed over the world, reaching their optimum development in semi-tropical and tropical climates. They are confined to the extreme southern region of the United States—in fact, to a narrow strip near the coast from Virginia to northern California. They are particularly severe in southern Florida and on the Florida keys, and to a slightly lesser extent in southern California.

As their name implies, non-subterranean termites, which include dry-wood, damp-wood, and rotten-wood species, have no contact with soil but rather attack wood directly. It is for this reason that they are, in a sense, more difficult to combat than the subterranean forms. There is little evidence of attack until damage occurs. There are no conspicuous colonizing flights, such as in the subterranean group, to indicate the presence of an infestation. However, such flights are made, and during the flights males and females shed their wings, pair off, and bore into the wood, sealing the entrance with a plug. Tunneling of the wood is begun immediately and increases in intensity as the colony grows. There are only two castes represented--the reproductives and the soldiers. While colonies are small compared to the subterranean species, considerable destruction is caused by the species before evidence of activity appears. One of the best signs of damage is the tiny pellets of partly digested food that the termites expel from their galleries. This may be of little value as an indicator, however, if the infestation is in inaccessible places.

This group of insects, particularly the dry-wood termite, is probably best known for its damage to furniture. However, any cellulose material may be attacked including woodwork of buildings, transmission line poles, lumber, paper, cloth, insulation board, etc. The problem is most severe in the Tropics--in Key West, Cuba, Puerto Rico, Panama, and Hawaii. Dry-wood termites are the No. 1 problem in wood deterioration in these areas.

Various methods of control have been tried for many years from the injection of insecticides into furniture with a hypodermic needle to enclosing and fumigating an entire building and its contents within a tent. Use of fine screen has been recommended to prevent entry of termites into buildings, and the application of heavy coats of paint has been employed to deter outside attack. Inorganic stomach poisons or contact insecticides, principally dusts, have been largely used for controlling infestations. These measures have been effective only to a limited extent, have been of a temporary nature and often impractical in application. As in the case of subterranean termites, recent development of new insecticides and wood preservatives gives considerable promise of more effective and permanent control. There is much to be learned about the methods of obtaining penetration of residual insecticides into the wood so that in addition to controlling active infestations, future attacks may be prevented. In localities where the problem is particularly severe, a preventive treatment of a permanent nature which may be applied to all wood in new construction or when replacements are made is especially important.

Wood Borers

There are several species of wood-boring beetles which present special problems in the deterioration of wood in waterfront structures. They include largely the groups known as wood borers and the powder-post beetles. Some may attack wood in the green log stage or the green lumber upon which bark flitches remain. They may survive air-drying treatment and, if the wood is utilized within one or two years, will continue their activities within structures. Most of the species complete their development from worms or larvae to adults within 2 years, emerge, and never reattack. A few will reinfest the wood and continue their destructive activities indefinitely. While the extent of damage caused by this group of insects is not well known, it nevertheless creates undesirable problems. Emerging borers make holes from 1/8 to 1/4 inch in diameter in the surface of the wood containing them. If paneling, wall board, flooring, or other material is laid over this wood, they will also bore through it in order to emerge.

By far the most destructive beetles are those classed broadly as powder post beetles and which attack seasoned wood. These attack the wood directly either during storage on the lumber yard or in a structure and continue their activities, breeding one generation of progeny after another until the wood is completely destroyed. Some damage wood

rapidly; others slowly but surely. While most of the species are distributed the world over, only a few have been studied sufficiently to determine their habits and control.

The group known as Lyctus powder-post beetles has caused concern in the wood-using industry for many years. This tiny black or brown hard-shelled insect attacks principally the large-pored hardwoods such as oak, hickory, ash, walnut, etc. While the green wood may be attacked in the lumber yard, it is usually the finished product that is attacked, and destruction is greatest when products are in storage. It is impossible to accurately estimate the total amount of destruction caused by these beetles to such items as flooring, wood gunstock blanks, cots, furniture, tool handles, dunnage, and other items in this country alone. It is equally severe in other parts of the world and several countries have recognized the problem to the extent that legislation has been employed in an effort to prevent serious losses and keep the insects under control.

Another powder-post beetle known widely for its destructive activities and one which is becoming increasingly important is the old house borer or Hylotrupes. The insect is a rather large one in both the larval and adult stages and makes channels and holes in the wood up to 1/4 inch in diameter. It attacks all soft woods and is found principally in large timbers such as joists and beams. Due perhaps to the increased use of sapwood, as pointed out early in the paper, it appears that the insect is becoming increasingly common in this country. This very point is brought out in a recent report from Sweden presenting results of a survey of wood destroying insects. This report also makes the statement that the cost of repairing existing damage caused by this borer in Sweden would amount to over $25,000,000. Reports from other parts of Europe, North and South Africa indicate a similar situation in these areas. The borer has not been so intensively studied in this country. However, it has been found in outdoor structures, such as in bridge timbers, poles, and piers, as well as in all parts of dwellings, warehouses, and like structures. The size of the insect plus the fact that its life cycle may be from 3 to 7 years, results in rapid destruction of wood. High temperatures and humidity favor its optimum development.

There are several other species of powder-post beetles which, because of small size and inconspicuous activity, attract little attention. Nevertheless, as a whole, they likewise cause severe damage. It is unusual to find foundation timbers, particularly in basementless structures, free from attack by one or more of these species. Unfortunately, presence of the insect is not detected until failure of timber is notedand, as frequently happens, the casual agent is ignored, the timber is replaced, and the general infestation continues.

One insect, known as the wharf borer, stands apart from the above insect in its relationship and habits. Although it has not received a

great deal of study it is known to be capable of doing considerable damage. It is usually associated with decay fungi in very moist wood and under such conditions has been observed hastening the destruction of piling, decks under wharves, boardwalks, telephone poles, fences, piers, and even buildings. It has been reported from numerous points in the United States, particularly along the coast, and from other parts of the world.

Very little is known regarding the biology and control of this insect. Treatment of wood with preservative deters its activity for a period of time, but it will attack wherever impregnations are poor or leaching of chemicals has begun.

There is much to be learned of the biology and practical prevention and control of wood boring beetles. It is believed that the residual action of new synthetic insecticides offers considerable promise in this regard. However, the method of introducing these chemicals into wood to reach deep infestations remains a problem. Fumigation of small buildings, furniture, or tool stock with methyl bromide is very effective but is limited because no protection from future attack is offered. It can not be used for large buildings or their contents. In some cases the impregnation of wood with a preservative by soaking or pressure treatment offers a worthwhile preventive approach. Chemical formulations and methods of application for control of these insects should be investigated.

NEED FOR RESEARCH ON PROBLEMS OF DETERIORATION

In the above discussions on various problems of deterioration, it has been repeatedly pointed out that there is a great need for additional research.

In the recent past, wood has been of high quality and a very plentiful commodity. Interest in the protection of wood products has therefore not been great. Consequently, until recent years research on wood-destroying organisms has been somewhat limited. In many cases it appears to have failed to keep abreast of the need for the preservation and conservation of wood products for the building industries. However, with the decrease in the timber supply, the development of innumerable wood products, and the high cost of such products due to increased cost of the raw material and its manufacture, a realization of the need has come about for research designed to protect this valuable resource.

Advancements in the fields of chemistry and engineering have provided promising materials for study. During World War II and since, there have been revolutionary developments in the chemical industry and in the production of potent residual insecticides, such as DDT, BHC, chlordane, toxaphene, heptachlor, and others, which far exceed most of the older insecticides in effectiveness. Considerable progress has also

been made in the development of new equipment, including numerous types of thermal fog generators, mist blowers, and improved hydraulic sprayers, to be used in the surface application of these insecticides. There have been also marked improvements in methods and equipment for impregnating wood with preservatives.

Outstanding though they are, these developments merely provide a tool for the control of the various organisms destructive to wood. Each insecticide must be investigated thoroughly to determine the formulation most effective and most practical in a particular situation. Each formulation must be compared with standard treatments and evaluated on the basis of performance and cost.

A most important consideration, however, is the need for basic biological studies of the destructive organisms involved. In the haste to obtain results—a characteristic of much of our research in the past decade—there has been a tendency to overlook the fact that development of effective control measures is dependent upon a knowledge of the behavior of the organism for which the control is directed. Thus, it appears that much of the research of past years has followed a hit or miss pattern. Fundamental research on the biology of the organisms, including life history, habits, and the relationship to the environment, is essential in order that control measures may be effective and economical. Among the insects a few species of our native termites and the powder-post beetles have been most extensively studied. Little is known, however, about many species of termites, powder-post beetles, and the numerous wood borers found in this country. The field of wood deterioration in the tropics is virtually unexplored.

There has probably never been a period in our history when interest and progress in the utilization of wood has been greater than at present. Conservation and protection are integral parts of this advancement, and research in these fields at this time can contribute much toward the progress being made.